THE MPLS JOURNEY

FROM CONNECTIVITY TO FULL SERVICE NETWORKS

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Agenda

- Introducing the Full Service Network
- The MPLS Journey
- From Connectivity to Full Service
  - MPLS VPNs
  - MPLS L2VPNs (AToM)
  - MPLS Traffic Engineering
- Summary: Full Convergence for Full Service
Benefits of An Integrated MPLS Full Service Network

- Deliver the richest set of business generating services on a single network infrastructure
- Minimize Capital and Operational expenditures while delivering these services
- Maximize network and service availability
- Enable new services such as Voice VPNs and Video on Demand
- Ease deployment and maintenance by combining resources and offerings
MPLS: The Key to Full Service Delivery

- ATM Services
- IP Services

- PNNI
- MPLS
- IP+ATM Switch

L2VPN Integration: ATM/FR/Eth Transport and Interworking

- Optical Services
- IP Services

- O-UNI
- MPLS
- IP+Optical Switch

IP+Optical Integration

- Frame Relay
- Frame Relay
- ATM

- MPLS VPNs: Scalable Network based VPNs
- Traffic Engineering: Bandwidth Optimization of traffic
- Bandwidth Protection and Resiliency Reduction in CAPEX & OPEX
- Layer 2 Integration for a single converged Network Infrastructure
- Reducing in CAPEX & OPEX

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The MPLS Journey
From Connectivity to Full Service

Connectivity
MPLS
VPNs

Multi-Service
MPLS
L2VPNs

Full Service
Traffic
Engineering
The Promise of an MPLS Full Service Network

Connectivity
- MPLS VPNs
- MPLS L2VPNs
- Traffic Engineering

Basic VPN Services
- Remote Access and Site to Site
- Site Backup and Resiliency Options

Multi-Service
- Integrated L2/L3 Service
- Global large scale IP VPN Extranet Services
- Integrated Internet Access
- Layer 2 Service Integration
- Virtual Leased Lines
- Bandwidth Protection and Restoration

Full Service
- Any Access, Any Service
- Managed Shared Service
- Voice and Video VPN Services
- Optical Transport Integration
MPLS VPNs
MPLS VPNs:
The Drive to Full Service

• Beyond connectivity – Deliver value-add IP services
• Consolidate network core into one infrastructure
• Ease Deployment, Provisioning and Maintenance
• Offer unified VPN choice for L2 or L3 based on service needs
• Provide flexible demarcation - Customer/subscriber managed, Managed CPE, Provider Edge
• Provision Managed Shared Services per customer
# MPLS VPNs – The Journey

## Business Drivers

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## Services and Enabling Technologies

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What are MPLS-based IP-VPNs?

- Scalable VPNs
- IP QoS and traffic engineering
- Easy to manage and No VC provisioning required
- Provides a level of Security equivalent to Frame-relay and ATM
- Supports the deployment of new value-added applications
- Customer IP address freedom
MPLS VPN Services: Global IP VPN Extranet Services

Requirement: Scale to large networks and multiple providers
Solution: Use MPLS Inter-AS and CSC
Benefits: Time-to-Service, Global Reach, Reduced Cost
MPLS VPN Services: Managed Shared Services

Requirement: Value-add Shared Services beyond Connectivity
Solution: VRF-aware Features such as NAT, DHCP, H.323, AAA
Benefits: Additional revenue sources, Shared Resources, Reduced Cost
MPLS VPN Services: Remote Access VPN Integration

Requirement: Establish secure connections between sites over public network

Solution: MPLS connectivity combined with IPsec

Benefits: Time-to-Service, Global Reach, Security, Flexibility
MPLS VPN Services: Traffic Prioritization for Data, Voice, and Video

Requirement: Service Differentiation for different types of traffic within VPN

Solution: CoS/ToS to MPLS QoS Mapping

Benefits: Improved response for prioritized traffic (Voice/Video)
MPLS VPN Full Service: Integrated Native IPv6 VPNs

Requirement: Offer IPv6 (along with IPv4) VPN Support through MPLS Backbone

Solution: Integrated IPv6 Transport (6PE) and IPv6 VPN

Benefits: Support for IPv6 applications, addressing space, etc.
MPLS L2VPNs
Layer 2 Service Delivery through Any Transport over MPLS
MPLS L2VPNs: The Drive to Full Service

• Market Drivers
  Services are more distributed and competitive
  Technology transitions from TDM to ATM to IP/MPLS
  Seamless service transition and transparency

• Service Provider Drivers
  Sustain existing business (ATM/FR) while rolling out new services
  Move from single service networks to single network offering multiple services
  Network price/performance profitability
  Service breadth and flexibility

• Single network for layer 2 and Layer 3 services needs
• Leverage high speed packet core (OC-192 and beyond) for all applications
# L2VPNs – The Journey

## Connectivity
- **Business Drivers**
  - Point to Point connectivity
  - Leased Line Connectivity

## Multi-Service
- **Services and Enabling Technologies**
  - Independent Transports
    - Separate Networks: ATM, Frame Relay Services
    - IP Network overlay: IP-over-ATM
  - L2VPN Service:
    - Any Transport Over MPLS (AToM)
  - Metro Ethernet Service:
    - EoMPLS, VPLS
  - Transport Independent Layer 2 Service:
    - L2 Interworking

## Full Service
- **Business Drivers**
  - Migration of Existing installed based to converged network
  - Ease of provisioning
  - Further OPEX, CAPEX Reduction

## Services and Enabling Technologies
- **Multi-Service**
  - Simple provisioning of services across existing networks:
    - ATM-MPLS Signaling Interworking
    - Any access Any service:
      - AToM, VPN, TE, and QoS integration
What is ATOM – Any Transport Over MPLS?
ATM, Frame Relay & Ethernet *Transport* over MPLS Infrastructure

CPE Routers

Virtual Circuits

MPLS Backbone

Cells/frames with labels

AToM Tunnels

One network any access
Layer 2 VPNs – Integrating Packet & Circuit Networks
Like to Like – Transport of L2 (Ethernet, Frame Relay, ATM, PPP, HDLC)
L2 VPN Services: 
AToM L2 Transport Interworking

Requirement: Transport Independent L2 Service w/full Interoperability 
Solution: L2 (AToM) Interworking 
Benefits: Most Flexible Layer 2 Transport Service Offering
L2 VPN Services: Metro Ethernet over MPLS

Requirement: Ethernet-based VLAN Service across MAN
Solution: AToM Ethernet-over-MPLS
Benefits: High Bandwidth, low cost properties of Ethernet for VPN Service
**L2 VPN Full Service: ATM – MPLS Signal Interworking**

**Requirement:** Simple provisioning across MPLS and existing ATM networks

**Solution:** Signal Interworking – ATM UNI to MPLS

**Benefits:** Easy migration from existing to new network services
MPLS Traffic Engineering
Managing Bandwidth Protection, Optimization, and Restoration
MPLS Traffic Engineering:
The Drive to Full Service

• Congestion in the network due to changing traffic patterns
  Election news, online trading, major sports events

• Better utilization of available bandwidth
  Intelligently spread traffic across non-equal paths

• Route around failed links/nodes
  Fast rerouting around failures, transparently to users
  Like SONET APS (Automatic Protection Switching)

• Build new services—Virtual leased line services
  VoIP toll-bypass applications, point-to-point bandwidth guarantees

• Capacity planning
  TE improves aggregate availability of the network
### MPLS Traffic Engineering – The Journey

**Connectivity**
- **Business Drivers**
  - Address bandwidth pressure on DS3 backbones due to Broadband deployments
  - Improve network link utilization
  - Traffic Prioritization

**Multi-Service**
- **Network Element Protection** for better SLA delivery
- Guaranteed Bandwidth
- Further improvement in network link utilization

**Full Service**
- **Rapid service provisioning** over combined optical and IP/MPLS core
- **Single managed infrastructure**

**Services and Enabling Technologies**
- **Network choke point relief:**
  - MPLS Traffic Engineering, QoS
- **Manual diverse routing:**
  - ATM VCs mapping, Routing protocol metric manipulation
- **Initial QoS delivery:**
  - CoS, Priority queuing

- **Network Protection and Restoration:**
  - MPLS TE Fast Re-route
  - DiffServ Aware TE
- **Bandwidth Guarantees:**
  - MPLS TE w/RSVP, Global Inter-Area TE

- **Optical Integration:**
  - GMPLS and OUNI with TE
  - **Voice Trunking/VPN:**
    - VPN, QoS, DiffServ Aware TE
What is MPLS Traffic Engineering? Explicitly Managing the Data Flow

- **Traffic engineering**
  - Aligning traffic flows to resources
  - Optimize link utilization
- **Fast reroute**
  - Fast, local, link and node protection
- **Guaranteed bandwidth**
  - Hard end-to-end bandwidth and delay guarantees

Conventional IP Routing is destination based and is based on simple link costs.
- Bandwidth availability is not taken into account
- Some links may be underutilized while others are congested

MPLS-TE supports explicit routing
- Lets you use paths other than IGP shortest path
- Allows unequal-cost load sharing
MPLS TE Services: MPLS Traffic Engineering for Bandwidth Provisioning

Requirement: Better QoS and Bandwidth deliveries for prioritized traffic

Solution: MPLS TE in MPLS core, combined with MPLS QoS

Benefits: Improved Bandwidth Inventory
MPLS TE Services: Diffserv-Aware Traffic Engineering

Find Route and Set Up Tunnel for 5 Mb/s of Voice From POP1 to POP4

Find Route and Set Up Tunnel for 3 Mb/s of Voice From POP1 to POP4

Find Route and Set Up Tunnel for 15 Mb/s of best effort from POP2 to POP4

**Requirement:** Bandwidth Guarantees for time/latency critical traffic

**Solution:** Diffserv-Aware MPLS Traffic Engineering

**Benefits:** Better service differentiation
MPLS TE Services:
Network Protection and Restoration

Requirement: SONET-like Network Protection and restoration over MPLS network
Solution: MPLS TE Fast Reroute
Benefits: ~50msec failover with both link and node protection
**MPLS TE Full Service: Optical Integration**

**Requirement:** Quick circuit provisioning over combined Optical/MPLS network

**Solution:** GMPLS with MPLS Traffic Engineering

**Benefits:** Unified control plane, maximizes service delivery
Summary
Full Convergence for Full Service
Layer 3 VPNs & Layer 2 VPNs
Traffic Engineering + QoS + IP Services

Legend

- Layer 3 VPN
- Layer 2 VPN
- Traffic Engineering

QoS mechanisms like Queuing and Policing are configured at CE and PE routers

IP Services like NAT, DHCP can be configured on per-VPN basis on the PE router

Traffic Engineering for Bandwidth protection and restoration

Layer 2 Circuits available – Ethernet, ATM, Frame Relay, PPP, HDLC

Layer 3 Routing protocols available on PE-CE – Static, RIP, OSPF, EIGRP, eBGP

IP/MPLS Backbone

The Full Service Network:
Integrated MPLS Technologies

Japan
The Full Service Network with MPLS: Ready - Today!

• Over 200 active Cisco IOS-based MPLS networks
• Supports legacy and new advanced services
• Infrastructure consolidation reduces OpEx/CapEx
• Additional revenue opportunity for Service Providers
• Increased productivity and lower cost for users
• You can deploy MPLS full service networks – Today!